Generation and tracking of inverse Compton scattering photons in Geant4

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Background: Inverse Compton scattering (ICS) is the process by which laser photons collide with relativistic electrons and, as a consequence of the interaction, boost their energy as a function of the polar scattering angle. Due to this correlation, it is possible to obtain a quasi-monochromatic radiation by simply collimating the scattered beam. This fact, together with other favorable features, such as a small emission spot and a high brilliance, makes ICS radiation interesting for medical applications. Photon sources based on ICS are among the most promising compact alternatives to synchrotron radiation and for this reason, many institutions have research program aiming at developing one of such sources. In the design phase, a tool for the simulation of ICS beams starting from the features of the colliding beams is very useful for the optimization of the source. Also, a tool for the tracking of the obtained radiation is crucial to foresee the source performance in the considered applications. In this work, we present a novel algorithm to generate in Geant4 ICS photons and, as an example, a specific application to assess the potential of ICS radiation in medical imaging.

Material and Methods: The algorithm to generate ICS photons is based on three novel classes which enable the definition of a inverse Compton radiation source as a primary particle source similarly to the built-in method of Geant4. A messenger class allows the user to set the parameters of the interacting beams, and thus of the radiation source, through a macro file. The generated photons can be tracked in the geometry directly or, alternatively, can be saved in a root file and read through a dedicated class to be tracked in a separate application. In this work, we compare the results obtained through our code with the ones provided by CAIN, a well established Monte Carlo code to simulate ICS radiation. Also, we show a tool through which the potential of ICS radiation in medical imaging, in particular in K-edge subtraction imaging, can be assessed.

Preliminary results: Our algorithm produces results in very good agreement with CAIN at a computational speed two orders of magnitude higher. The presented code can be easily integrated in a user application to track the generated ICS photons in a given experimental setup, in particular the ones involved in medical applications.